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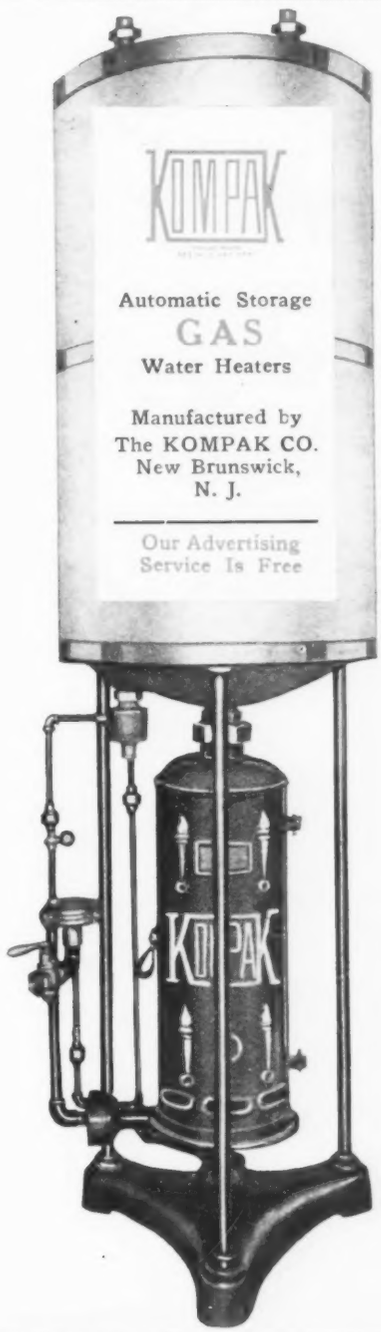

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INDEX TO CONTENTS, PAGE 9 ADVERTISERS' INDEX, PAGE 24

SCRUBBERS

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Bleaching Operations That Offer Field for Gas

How Various Processes Are Carried on—Rubber, Hair, Shellac, Paints, Corks, Etc.

By GILBERT C. SHADWELL

Here are just a few common materials which are bleached for most or at least some purposes: Beewax, bristles, bones and bone goods, calico, coral, cotton, print paper, printed products (such as engravings), feathers, flannel, animal glue, certain grades of rubber or "gutta percha," hair, hats, horn, ivory, pite, lac or shellac, leaves, oils, fats, paraffin, piano keys, rosin, sails, silk, handkerchief, sponges, straw, starch, tallow, textiles, paint, corks, wax, wood, and so on almost without number.

Oxygen and sunlight are good bleaching agents, and so is bleaching powder, but as they only partially interest the gas man, we will not deal with them at any length except briefly, a little later on in connection with the other processes. To begin with, however, there was invented almost a decade or two ago a rather remarkable bleaching compound which consists of three parts by measure of mustard seed oil, four parts of melted paraffine, three parts of caustic soda at 20 deg. Baume, all well mixed to form a saponaceous or soap-like compound, of this, one part of weight and two parts pure tallow soap are well mixed and of this mixture 1 oz. for each gallon of water is used for the bleaching bath, and 1 oz. of caustic soda at 20 deg. Baume for each gallon is added when the bath is heated in a close vessel, such as a cauldron furnace with a lid on it, the goods entered and boiled until sufficiently bleached. Right here it may be said that there is on the market a gas-fired clothes boiler. The usual capacities are all the way from 30 up to 200 gal. and taking from 60 to 300 cu .ft. of gas an hour.

Briefly, these gas-heated clothes boilers are designed in the regular way for use in hotels, institutions, laundries, etc.

They fill the wide gap between the kitchen clothes boiler and the immense laundry boiler. Their simplicity, convenience, and efficiency will immediately appeal to those having use for such a device. But gas men will readily see how well such an equipment fits in gas work such as we have just spoken of.

This kind of an equipment can also be used for several other bleaching processes which we will describe hereafter.

There is, what is called an "instantaneous" bleaching fluid. This is made as follows: To water heated to a temperature which may vary from 190 deg. Fahr. to 212 deg. Fahr. there are introduced separately: mother of parl, indigo, cochineal, chloride of lime, soda crystals and potash. They boil this for half an hour and the preparation is then ready for use. The product is an invention of some 10 or 15 years back, but the inventor claims that the mother of pearl gives softness, luster, suppleness, etc., and gives to hemp the feel of cashmere. The indigo gives a slight azure tint, the cochineal adds brightness, the chloride effects the bleaching, the soda washes and brushes, and the potash removes all grease. However that may be there are quite a few concoctions of the same order on the market, and as the gas man is mainly interested in selling gas and gas appliances, and as they all can use these commodities, it is just as well to know something about them.

Now coming to our old friend bleaching powder, or as some people call it chloride of lime. This is prepared by passing chloride gas into boxes of lead in which a quantity of flaked lime is laid on shelves.

The stuff to be bleached is first boiled in lime water, washed and without drying, boiled again, in a solution of soda or potash. Again they wash it and without drying they steep it in a weak mixture of this chloride of lime or chlorinated lime and water for almost six hours. Then they wash and without drying steep for four hours in a weak solution or mixture of sulphuric acid and water. If the acid is too strong it "eats" holes, so this point has to be looked after properly. At this point they wash well and dry.

Bleaching Beeswax

Pure white wax is obtained from the ordinary beeswax by exposure to the influence of sun and weather. If this was all there is to it we could pass it up, but there's quite a bit more, so we'll go on.

The wax is sliced into thin flakes and laid on sacking or coarse cloth, stretched on frames resting on posts to raise them off the ground. The wax is turned over at frequent intervals and occasionally sprinkled with a soft water, if there is not dew and rain sufficient to moisten it. This takes something like four weeks to complete the process. If on breaking the flakes the wax still appears yellow inside, it is necessary to build it again, and here gas is a very useful substance. It means

that after it is melted it has to be flaked all over again and exposed a second time or even oftener before it becomes thoroughly bleached, the time required being mainly dependent on the weather.

There is a preliminary process by which it is claimed much time is saved in the subsequent bleaching; this consists in passing melted wax and steam through long pipes so as to expose the wax as much as possible to the action of the steam; thence into a pan heated by a steam bath, where it is stirred thoroughly with water, and then allowed to settle. The whole operation is repeated a second and a third time, and the wax is then in a condition to be more readily bleached. A gas fired steam boiler will find a sure place in such an installation.

Bleaching Bristles, Bones, Etc.

The bleaching of bristles is not a difficult operation. First of all they clean them in a preparation of tepid water and soft soap. The use of a clothes boiler is pretty good, but a tank furnace is better. They are then dipped in cold water. For two or three days they are then left in an aqueous solution of sulphurous acid. After this they are washed and dried. Here again the drying is a job for the gas man and he has air heaters, blowers, radiators, etc., at his beck and call to help him out.

Bones and bone products are bleached by dipping them for a few moments in a boiling solution of caustic soda and water. They are then rinsed thoroughly in water, rubbed down with fine pumice stone and exposed until whitened to the vapor of burning sulphur largely diluted with air. They then rinse in warm water. Bones and bone products may also be whitened by exposure in a weak solution of Javelle water.

The bleaching of calico is usually done by boiling it in a strong solution of caustic soda. It is then rinsed thoroughly in clean water; it is next steeped for half an hour in a strong clear solution of chloride of lime in water; after this they wring out and pass through water containing 33 per cent sulphuric acid. It is next rinsed thoroughly in running water and dried.

Bleaching Cotton

In bleaching cotton the first method is to make a strong solution of chloride of lime (i. e., bleaching powder, or as they call it hypochlorite of lime), in water, allow to settle and draw off the clear liquid. Next they rinse the goods in clean water containing about 5 per cent of sulphuric acid and then pass them slowly through the bleaching solution. Then they have to be well rinsed in water containing a little carbonate of soda. If the cloth is much colored it may be necessary to allow it to remain for a short time in the bath. This is the usual method of bleaching in laundries, but it is not necessarily good.

Bleaching Engravings

Generally they immerse the prints for one minute in Javelle water containing a little hyposulphite of soda. To prepare the Javelle water they take 4 ozs. of bicarbonate of soda and 1 lb. of chloride of lime. They put the soda in a kettle, or better still a gas-fired cauldron furnace and add 1 gal. of water. It is now allowed to boil 10 or 15 minutes after which the chloride of lime is stirred in; avoiding lumps, when cold, the liquid can be kept bottled ready for use.

Bleaching Feathers

The bleaching of feathers is of distinct importance as much of this class of work is done where the gas man can get a look in, in almost every case.

Broadly speaking, there are three main ways of carrying out the process or perhaps more strictly speaking, there are three processes.

The feathers are put into a bath of permanganate of potash, a solution of sulphate of magueria and heated to 140 deg. Fahr. The feathers previously washed, are put into this bath, then taken out, rinsed and passed through weak sulphuric acid.

It is also possible to bleach the feathers in a bath of one part of barium peroxide in 100 parts of water at 86 deg. Fahr. They leave the feathers for 48 hours in this solution, wash, pass through the weak acid bath and then wash again and dry.

Feathers are also sometimes bleached by exposure to the vapor of burning sulphur, which is in effect anhydrous, sulphurous acid. They usually conduct it, however, in a moist atmosphere. But it is usually necessary to remove the only matter from them before they can be satisfactorily bleached in this manner. This may be acomplished by immersing them for a short time in good naphtha or benzine, rinsing in a second vessel of the same and thoroughly drying. The drying is usually done by fanning and churning up the feathers in what can be called an agitator closet, where they are fanned almost continually, but it seems that an air heater shower ought to be just the thing for this class of work. Anyway, the whole treatment will not injure the feathers.

Bleaching Flannel

Flannel, which is naturally yellow or has become so, may be bleached by putting it for some days in a solution of hard soap to which strong ammonia has been added. The same object may be attained in a shorter time by placing the flannel for a quarter of an hour in a weak solution of sulphite or sodium to which a little hydrochloric acid has been added. This is the system adopted in large institutions, etc., quite often.

Bleaching Animal Glue

The most general method of bleaching animal glue is to take fine white glue prepared from rabbit skins for dressing white tissues and add to it a small quantity of sulphate of soda and mix well. Acetate of lead is then added, whereby a precipitate of sulphate of lead is brought about. The resulting jelly is thus bleached and after cooling (because the mixture is heated up originally) it is cut up and dried as usual.

Bleaching Rubber

The bleaching of rubber or gutta percha (the pure form of rubber) is carried out in two ways: In the first method they dissolve the rubber in 20 times its weight of hot benzole, add to the solution plaster of very good quality and agitate the mixture. This is usually done in a closed kettle with tight lid (having a safety valve

and pipe to connect with a condenser and thus avoiding danger as well as collecting any escaping vapors). It is usually direct fixed and can readily be gas heated.

The operation is relatively speaking, a rather long one, because they leave it to rest for a couple of days which causes the plaster to be deposited, and in doing so, the deposit carries down with it practically all the impurities which are not volatile in the benzole. The clear liquid, when decanted, is introduced by small proportions at a time into twice its volume of alcohol of 90 per cent, agitating continually. During this operation the gutta percha is precipitated in a state of a pasty mass, perfectly white. The drying of the material thus purified used to take several weeks when it was dried by exposure to the air, but with steam and air in circulation the time can be cut within half. A gas-fired air heater is excellent for such work.

The second method which is of greater interest to gas men is carried out as follows: White gutta percha is obtained by precipitating a solution of ordinary rubber (pure commercially) in chloroform by alcohol, washing with alcohol and finally boiling it in water. It is moulded into the desired form while still hot. Rubber in this form has numerous uses for scientific and similar purposes.

The Bleaching of Hair

So far as the bleaching of hair is concerned we are interested in the treatment of such hair as is used for wigs, brushes, etc., and not on the human head. In carrying out this work the hair is steeped in the following solution: In an enameled cauldron furnace, a hot diluted solution of nitric acid is most effectual. The brown kinds of hair, when carefully treated, is turned to the most brilliant golden, resembling golden spun glass. The method usually employed is to put the hair in a porcelain dish with dilute NO_2HO, or as usually termed HNO_3—nitric acid. This is then gradually heated and as soon as the required shade is obtained it is taken out and washed. If the acid is too strong, or the heat too great, the fiber of the hair is spoiled. Dark brown hair acquires, generally, a reddish color and black hair will form nearly white. The other method adopted for making wigs, witches, etc., is understood to bleach hair white instead of blond or yellow. This is done by mixing 1 lb. hydrogen of peroxide with 1 oz. cream of tartar dissolved in 1 oz. soda. The two solutions are blended and 1 lb. of the hair is steeped in it for 3 hours. After this they wash in clean water with soapine in a bath of pottery or clay and thoroughly dry either by the natural method or else assisted with hot air in motion. The drawback to the process is that it often has to be repeated, fourteen or fifteen times. However, after the twelfth and each succeeding time, the hair has to be thoroughly shaken up. Finally the hair is drawn through a solution of blue aniline and alcohol.

The bleaching of hat, such as the Panama type, is not widely different from the above. In this case the articles are washed clean and while slightly damp, are exposed to the fumes of burning sulphur in a closed vessel. The treating of each one dozen hats requires the above mentioned quantity of material.

Horn is another material treated in a somewhat similar way. Braids can be bleached by immersing for a short time in water, slightly mixed with sulphuric acid, chloride of lime, or chlorine, or it may be exposed in the moist state to the fumes of burning sulphur largely diluted with air. A gas burner under the sulphur allowing "overventilation" is a good proposition.

Bleaching Ivory

The raw ivory as brought to this country is of a yellowish and dirty color. Before it can be put to commercial use, in the thousand and one ways in which it is employed, it must be properly bleached and rendered of the same color in all parts of its surface.

Usually, they first clean the ivory by boiling it with a paste composed of pumice stone and water. After cleansing, they place the article under a glass vessel and expose it to the sun's rays until it answers its proper whiteness. The ivory has to be kept moist with water while bleaching. If the first operation does not succeed properly, it has to be repeated.

A quicker method, more often adopted, is to mix a thin lime paste and heat over a burner or in an oven. The ivory is placed in this paste and left until it is bleached white, after which the paste is removed and the ivory is dried and polished.

A method known as "Artus" process is used to quite some extent on the highest grade of ivory. In this process the ivory articles are placed in a solution containing carbonate of soda in crystals and water, and allowed to remain in solution for 24 to 48 hours. The articles are then removed from the solution, well washed in pure water and then immersed for five or six days in a solution composed of 17 ozs. of sulphite of soda and 45½ ozs. of water.

A glass or porcelain vessel has to be used because the acid acts on metallic vessels. A very fine polish can be put upon the ivory by the use of putty powder and water applied by means of a rubber made of an old felt hat. If the ivory articles are of a character to be placed in a lather, they may be polished by the use of pulverized pumice stone mixed with water after which the ivory has to be heated. This can be done in a low temperature oven, but is also done by rubbing it while revolving in the lather (if it is of such a shape that this can be done) with a piece of linen or sheepskin, and when it has become hot it has then to be rubbed with a little whiting mixed with olive oil, then with a little whiting and finally with a piece of soft rag. This can all be done with the usual mechanical equipment.

Again hydrogen of peroxide is used to bleach the inferior ivory used for knife handles. The mode of procedure is as follows: They place, say 2 quarts of the liquid in a stone pot, adding 4 ozs. of liquid ammonia fortis and then immerse the handles. It is then set over a sand bath on an industrial stove for 24 to 36 hours. The handles are then taken out and gradually dried by exposure to the air. But this must be done slowly, because otherwise they are liable to split; thence if an air heater be used, the humidity must be fairly high or the temperature and air supplied must be low. The deep color of the ivory is removed and a beautifully pearly white ivory results when polished.

The ivory is previously treated with a solution of common soda to get rid of greasy matter and open the pores.

There is quite a little work done on ivory by the various concerns making a business in antique works in ivory. These when discolored, are often brought to a renewed whiteness by the simple method of washing in hot water and exposing to the under glass.

There are probably a dozen other processes, but the subject has been given all the attention which it is believed it merits from the gas man's standpoint.

Bleaching Jute

Jute is considerably less tolerant of chemical agents than linen, especially of acids. For bleaching, let us say 50 lbs., however, the following seems to be the usual method adopted: They make up a solution of soap at 140 deg. Fahr. and pass the jute five times through it. It is then rinsed in clean water. For the chemic bath there is mixed chloride of lime with an equivalent quantity of sulphate of magnesia, both dissolved in water. This is then stirred up. The jute is then steeped for three hours in the cold, care being taken to keep the goods below the surface of the liquid. They are then taken out and washed.

The bleaching of lac is accomplished by dissolving shellac in a lye of pearlash by boiling. It is then filtered and chlorine is passed through in excess. It is then washed and precipitated, after this it is melted into sticks. This makes the highest grade of varnish with alcohol; its color also renders it good for white and delicate colored Traling wax, and so forth.

Bleaching Oils and Fats

Many plans and processes for decolorizing oils and fats are in vogue when exposed to sunlight in large white glass bottles; the oil soon becomes colorless, but it acquires an almost rancid flavor. A better way, therefore, has to be adopted. This is carried out as follows: The oil is first agitated with water containing gum, and to the solution thus formed is added coarsely crushed wood charcoal. The whole is then slowly warmed to a degree not reaching 212 deg. Fahr. in a cauldron furnace and when cold, the oil is dissolved out by ether or a high grade of petroleum spirit (gasoline) and this latter is recovered again by distillation. The result is said to be good.

The Bleaching of Rosin and Shellac

Rosin is bleached by melting the material and then forcing steam through the melted mass. The rosin is often heated to as high a temperature as 500 deg. Fahr. in a closed bottle and volatilized. The apparatus is in effect a still. The steam and rosin are then condensed in a receiver and the product is dried. Carbonic acid or a mixture of carbonic acid and nitrogen or hydrogen gas are introduced sometimes in order to perfect decolorization. Rosin oil is one of the products of the destructive distillation of rosin, the residuum being tar.

Regarding shellac, however, there are several methods, all of which are of interest to gas men. In the old days they formed the shellac into thin threads and exposed them to the atmosphere. In more recent times, however, one or the other of the following ways is usually adopted:

Each pound of shellac is dissolved in 4 lbs. of very strong alcohol, 1 lb. of bleaching powder, containing at least 20 per cent bleaching chlorine, mixed into a paste with water, strained through linen, and the whole washed with water until the filtrate amounts to 1 lb. It is then mixed with a solution of carbonate of potash in three parts of water, until no further precipitate is produced. The precipitate is separated by filtration. The alcoholic solution of shellac is warmed over a burner in a water bath and this warm solution is treated with hydrochloric acid until the mixture is decidedly acid. The shellac then separates as white dots, which have to be washed until the water ceases to pass away milky. It is then rolled out into thin strips upon a wet board.

The next method is called Lemming's method. It consists in either boiling or filtering the hot alcoholic solution through well burnet and recently heated animal charcoal. When necessary this operation is repeated until the solution is colorless, when it is filtered through fine silk and finally through fine filter paper. To insure success the solution has to be in the proportion of about 5 ozs. of shellac to 1 quart of alcohol.

The Bleaching of Silk

In carrying out the bleaching of silk, the articles to be bleached must be freed from all mechanically adhering dirt, grease, etc. This is effected according to the nature of the article and of the impurities to be removed, by means of soap, ammonia, sulphuret of carbon, ether or alcohol. These cleaning agents must then be entirely removed either by washing or by evaporation. A bleach bath is then made up with the peroxide of hydrogen, either alone or along with small traces of ammonia or of soda lye. The silks are simply laid in this liquid and left to steep as may be required. The process is accelerated by heat not exceeding 77 deg. Fahr. and by the light of the sun. The bleaching process may last for from two to fourteen days.

When it is completed, the silks are rinsed in condensed steam water and carefully dried.

In China, silks are scoured with carbonate of potash or of soda, but this method has been nearly abandoned in Europe on account of the amount of care and attention it required.

Bleaching Small Articles

Articles, such as pocket handkerchiefs require to get a good stewing in a warm oven. Often having to be left in a good large pan for a time until they look white as a preparation for washing they always steep white, not colored printed ones, in cold water for a few hours, and then they can be very well cleansed. The rest of the method is hardly useful to the gas man.

U. G. I. Stock Subscribed

Under the allotment offer to United Gas Improvement Company, Philadephia, Pa., stockholders to subscribe to $6,103,000 7 per cent preferred stock at par, $50 per share, about 18 per cent of the new stock was taken. There were 20,452 shares subscribed for and paid for in full, and 2,606 shares subscribed on which the first instalment was paid, making total of 23,058.

Possibilities of Large-Scale Use of Oxygen in Gas Production

H. J. Hodsman and Prof. J. W. Cobb Declare Provision of a Cheap Supply of Oxygen Would be One of Most Effective Ways of Promoting Economy and Efficiency in Utilization of Coal Supply

Gaseous fuel is produced from coal by methods which fall under two headings: (1) Carbonization; (2) gasification. To assess the relative thermal efficiency of these processes, it is necessary to consider the minimum expenditure of heat theoretically required by each, and how nearly the minimum is approached in practice, declared H. J. Hodsman and J. W. Cobb in a British Institution of Gas Engineers paper on "Oxygen in Gas Production." It is an arresting fact that each process can theoretically be carried out with a very small expenditure of heat; and yet present practice still stands far behind the ideal.

In carbonization, raw coal is heated to an appropriate temperature, at which it splits up into products—solid, liquid and gaseous. These are again cooled down to air temperature; and under good conditions practically the whole weight of material is recovered. Furthermore, the total heating power of the products is almost equal to that of the original coal. In practice, a considerable proportion of the heat of the coal is expended in carrying out this series of operations. Theoretically, however, much of this is unnecessary, and due to the imperfections of practice. It may even be held that the process occurs with the evolution of heat; so that, once started, it would be self-propagating. But the experimental data leading to such a conclusion are not well established, and have not sufficient regard for the difference of the carbonizing temperature and that of the air. Euchene and others attempted to measure the proportion of the heat expended as fuel which was actually utilized in the resolution of the coal in the retort. Their results justify the conclusion that the amount is relatively very small, and leave some uncertainty as to whether it is positive or negative. Hollings and Cobb, in a thermal analysis of the carbonization process, divided it into stages. It can be concluded from their work that, while the process as a whole is almost thermally neutral, some stages are undoubtedly exothermic. The combined evidence makes it certain that in any case only a small fraction of the heat of the coal is theoretically required to resolve it into its proximate constituents by dry distillation.

The solid coke residue of carbonization can also be gasified at high temperatures, either by the application of a blast of air alone or by air mixed with steam by the well-known reactions:

(1) $C + \frac{1}{2}(O_2 + 4N_2) = CO + 2N_2 +$ 29,000 calories.

(2) $C + H_2O + H_2 -$ 29,000 calories.

It is to be noted that the heat evolution of reaction (1) is the same as the heat absorption of (2). Neglecting for the moment the influence of temperature on the reactions, it follows that if the proportions of air and steam be suitably chosen, the process can be carried on continuously without the supply of external heat. This is, of course, the basis of modern gas producer practice using an air-steam blast. At a lower temperature the action of steam approximates more to the reaction:

(3) $C + 2H_2O = CO_2 + 2H_2 -$ 19,000 calories

absorbing less heat per unit of carbon, while the action of air generates more heat by the formation of carbon dioxide. Under these conditions the air supply to maintain the balance of heat would be proportionately less than the above; and in practice both carbon monoxide and carbon dioxide always are formed. In any case the carbon is gasified continuously without the application of external heat; and the heat evolved by the partial combustion of carbon in air is used to keep going the production of water gas by the interaction of carbon and steam.

Thus the combined processes of the carbonization of the raw coal and the complete gasification of the residue are such as to require only a small expenditure of heat. And yet in carbonization 20 per cent or more of the calorific value of the coal may be expended. In the gas producer process the difficulty encountered is due to the fact that the atmospheric oxygen utilized is inevitably loaded up with nearly four times its volume of nitrogen. The gas produced contains 45 per cent or more of inert constituents, which complicates the problem of distribution and utilization for general heating. It also involves a loss in the sensible heat of the gas leaving the producer. These difficulties have been partially circumvented in the ordinary water-gas process, where the reaction of coke with air has been separated from the reaction with steam so that the products of the former, contaminated with nitrogen, are excluded from the water gas produced. The price paid for the elimination of the nitrogen is, however, a heavy one. A large part of the heat of combustion of the carbon consumed in the "blow" is lost. The total loss amounts to some 30 per cent of the calorific value of the original coke gasified. In addition, there is the heat expended in producing the coke; although this does not apply to any form of water-gas generation such as that of Tully, which works with coal. Furthermore, the continuous operation of the gas producer has to be replaced by the intermittent operation of the water-gas generator with all its attendant complications.

Serious difficulties stand in the way of attaining the thermal ideal of carbonization. The coal (a poor conductor) must be heated to, and maintained at, a high temperature by heat transmitted through refractory materials, which are themselves equally bad conductors. Hence carbonization by external heat will probably never approximate to the ideal. More promising are methods in which the heat is produced in the charge itself; and we have examined one which offers distinct

possibilities, however Utopian it may appear at first sight—viz., generating the heat for carbonization by the use of a regulated supply of oxygen. Assuming for the moment that oxygen is available in practice for this purpose, it is clear that certain difficulties in the way of the continuous gasification of the coke residue by the combination of reactions (1) and (2) do not arise. Furthermore, when blown with a mixture of oxygen and steam the coke could be converted into gas with a small expenditure of heat; while the sensible heat of the water gas could be used for carbonizing the coal. The complete gasification of coal might then be attained with maximum thermal efficiency.

There is another important consideration in a continuous combination of carbonization and gasification by internal heating. There must be a certain balance between the rate at which heat is generated in one part of the charge and the rate at which it is transferred to another and there utilized. These must be mutually appropriate, if continuous and economical working is to be maintained. The conditions are somewhat complicated and difficult to foresee exactly; but it seems probable that carbonization by oxygen alone would be unsatisfactory on this account. The hot gas generated by the combustion of a portion of the coke at the bottom of, say, a vertical retort would not be sufficient in volume and thermal capacity to transfer enough heat to the rest of the coke and to complete the distillation of the coal. There would be great liability to local high temperature combustion of the coke, with insufficient heat elsewhere. Again, if all the coke were sufficiently heated it would have to be discharged at a temperature too high to be economical or practicable in a continuous process. In ordinary producer practice there is more than sufficient heat carried by the gases (including nitrogen); and, as a result, the column of coal and coke can be heated throughout and the gas still pass out at a high temperature—say, at 500 deg. Cent. It seems probable, then, that, to work continuously, a process of internal carbonization must be accompanied to some extent by a process of gasification with steam, whereby heat is extracted from the coke and a current of water gas provided. The extent would require to be determined experimentally. In what follows we have assumed the introduction of just as much steam as could be heated up and decomposed by the coke during its descent in a continuous retort.

Gasification and Carbonization of Coal by Oxygen

Imagine a charge of coal descending a vertical retort or producer, up which passes a regulated current of oxygen and steam, so as to consume a small proportion of the coke produced—the rest passing downward to be drawn at the bottom. The heat produced in the charge will in part be carried up by a current of hot gases, and used to carbonize the raw coal in the upper part of the charge. The mixed gaseous and vaporous volatile matter will be carried out of the retort to the cooling and purifying plant. Now, apart from any heat theoretically involved in the resolution of coal into its proximate constituents (which is known to be small or non-existent), there will be a number of heat losses inevitable in carrying out the operation on an industrial scale; and the sum-total of these will represent the minimum quantity of heat which must be supplied to effect carbonization. We have made certain assumptions as a basis for calculating this quantity. The heat necessary is supposed to be provided by the combustion of part of the coke with oxygen. The carbon consumed is taken as being converted wholly into CO—i. e., the producer gas reaction is assumed to proceed at a high temperature. The steam also is supposed to be completely decomposed to give an ideal water gas ($CO + H_2$). Actually some CO_2 would be produced; but speculations as to the equilibrium composition of the gas (which is of secondary importance) are unnecessary at this stage.

We have taken as a basis for calculation the results obtained for the production of straight coal gas in the Gas Investigation Committee's experiments at Uddingston. This was done not because the results were specially favorable but simply because they were the most complete and reliable at hand. As the coal used contained 9.8 per cent of water, we have, for convenience of calculation, taken the figures on the dry basis as being nearer to normal gas-works practice, and have recalculated them to refer to 100 kg. of dry coal.

Carbonization of 100 Kg. of Coal Without Steaming in Glover-West Vertical Retorts at Uddingston

Coal—

100 kg. dry coal—heating power 7,000 k. cals. per kg.

Composition—	Per Cent
Ash	7.0
C	74.5
H	5.6
S	1.3
N	1.9
O	9.7
	100.0

Gas—

27.0 cubic meters at 0 deg. Cent. 760 mm. dry.

Composition—	Per Cent
CO_2	2.2
O_2	0.4
CmHn	2.3
CO	10.3
CH_4	28.5
H_2	49.5
N_2	6.8
	100.0

Tar—

7.1 kg. with heating power 9,130 k. cals. per kg.

Coke—

66.4 kg. of dry coke with heating power 6,925 k. cals. per kg.

Composition—	Per Cent
Ash	10.1
Volatile matter	2.1
Fixed carbon	87.8
	100.0

Owing to the low thermal conductivity of coal and refractory materials, carbonization retorts must have a small cross-section. With internal heating, the necessity for this would disappear; and, indeed, increasing the section would within limits be an advantage. This would lead to increased rates of gasification. For the purpose of calculation we have, therefore, imagined the processes as carried out in a cylindrical chamber 11 ft. high and 10 ft. in diameter, with a fuel bed 8 ft. deep—i. e.,

in a vessel resembling a typical gas producer. Indeed, a process of internal heating would be an approximation to a gas producer rather than to normal carbonization practice.

The process, however, could be carried farther so as to gasify the coal completely by a current of a mixture of steam and oxygen. We assumed, therefore, the process of complete gasification to consist of the two successive stages—carbonization followed by gasification of the resulting coke.

The heat expended in the charge in various ways, and furnished by external or internal means, falls under several headings. We have attempted to appraise these various items in terms of the calorific value of the original coal in the sections which follow; and the results are brought together in Table I.

TABLE I—*Carbonization and Gasification of* 100 *Kg. of Coal by Internal Heat (Oxygen and Steam)*

Expenditure of Heat (in equivalent weight of coal)	Carbonization with Steam	Complete Gasification
Sensible heat of crude gas at.....	100°	300°
(a) 27 cu. m. (N. T. P.) straight coal gas	0.14 kg.	0.42
(b) Water vapor	0.91	1.04
(c) Tar vapors	0.13	0.21
(d) Carbon monoxide	0.056	0.92
(e) Water gas	0.065	1.12
Heat content of coke or ash residue	0.39	0.025
Heat lost through walls.....	0.50	1.000
Heat expended in external work on expansion	0.14	0.355
Total heat loss in process.....	2.33	5.09
Heat of formation of water gas to be supplied	Nil	7.75
Total heat to be supplied by combustion of carbon.....	2.33	12.84
Composition of gas produced—		
CO_2	1.1	0.33
O_2	0.1	0.06
H	1.1	0.35
CO	41.9	63.2
CH_4	14.2	4.27
H_2	38.3	30.8
N_2	3.3	1.0
	100	100
Volume of gas produced cu. m. (N. T. P.)	54.3	180.0
Calorific value—k. cals. per cu. m. at N. T. P.....	4,064	3,350
Thermal balance sheet—		
Heat in coal.....	100	100
Heat in gas.....	31.6	85.9
Heat in coke.....	53.3	
Heat in tar.....	9.26	9.26
	94.16	95.1
Heat expended in process.....	2.33%	5.1%
Efficiency of gas production (no deduction for steam and power)....	93.3%	94.4%
Cu. ft. of gas per ton at 60° F., 30 in., moist	20,900	69,100
Calorific value per 1,000 cu. ft. at 60° F., 30 in., B.t.u. gross.....	427	352
Cu. ft. oxygen required per ton of coal	2,275	12,340
Cu. ft oxygen required per 1,000 cu. ft.	107	179
Cu. ft. oxygen required per 100,000 B.t.u.	25	51
Steam req. per 100 kg. coal treated..	5.9 kg.	33.7 kg.
Steam required per ton coal treated..	132 lb.	755 lb.
Coal equivalent of steam (70% efficiency) per 100 kg. coal.....	0.75 kg.	4.27 kg.
Efficiency of gas production (fuel for steam deducted)	91.1%	90.1%

Sensible Heat of the Gases

For the purposes of calculation we assume the gases leaving the retort or producer to consist of:

(a) The straight coal gas obtained in the test quoted.
(b) The ammoniacal liquor in vapor form.
(c) The tar vapors.
(d) The carbon monoxide produced by the combustion of part of the coke.
(e) The water gas resulting from the reaction of carbon and the steam blown in.

These gases, if hot, would carry out of the apparatus a considerable quantity of heat, and should therefore pass out at a low temperature. In carbonization we have taken this as about 100 deg. Cent.—a figure regularly attained in vertical retort practice. In complete gasification the figure must inevitably be higher. In producer practice it will be from 500 to 600 deg. Cent.: but if the atmospheric nitrogen is excluded (as in the process under consideration) a lower temperature should be attainable. We have taken 300 deg. Cent.—a mean of producer and carbonization practice—as the basis of our calculation.

Straight Coal Gas

The new conditions postulated would, doubtless, have an effect on the quantity and quality of the gas distilled; but this, although sufficient to influence individual items, would not modify appreciably the end result of the calculation. Taking the specific heat of 1 cu. m. of coal gas as 0.36 kg. cals. (Bunte), the heat capacity of 27 cu. m. from 100 kg. coal would be 2,198 kg. cals. at 300 deg., equivalent to 0.42 kg. of the coal, and accordingly to one-third of this, or 0.14 kg. of coal at 100 deg. Cent., taking the air temperature as 0 deg. Cent. for simplicity of calculation. This would be increased by a small but negligible quantity, due to the sulphureted hydrogen and ammonia in the crude gas.

Water Vapor Afterward Condensed to Ammoniacal Liquor

The quantity of virgin liquor was not available, but is certainly not greater than 10 kg. per 100 kg. of coal which is taken. The heat capacity of 10 kg. assumed to be all water, raised to 300 deg. Cent., is 7,300 kg. cals., equivalent to 1.04 kg. of the coal. At 100 deg. Cent. the value is 6,370 kg. cals., or 0.91 kg. of the coal. This item covers only the water produced from the coal

itself. The small quantity which may have passed from the bottom of the fuel bed undecomposed is neglected.

Tar and Tarry Vapors

It is more difficult to estimate the heat capacity here, first, because of the complexity of the tarry matter, and, secondly, because it is uncertain how much is carried out in the form of vapor and how much as finely divided liquid. Fortunately, the latent and specific heats of tar constituents are small compared with those of water, so that the whole item is only small. We have taken the tar as being in the vapor state to avoid an underestimate. The latent heat is assumed to have a mean value of 90 kg. cals. per kilogram and the specific heat a mean value of 0.4 per kilogram, both for the liquid and gas. Upon this basis the heat capacity of 7.1 kg. of tar vapor at 100 deg. is 923 kg. cals., equivalent to 0.13 kg. of coal. At 300 deg. Cent. this becomes equal to 1,490 kg. cals., or 0.2 kg. of coal.

The Carbon Monoxide

The carbon monoxide to be considered is that produced by the partial combustion of the coke in supplying the heat necessary to effect the carbonization or gasification process. For the purpose of this calculation, the producer gas reaction is taken to be that of hot working —say, above 1,000 deg.; and it is assumed that the proportion of carbon dioxide formed is negligible. While not strictly valid, it should be approximately true; and any probable deviation will not seriously affect the thermal balance sheet as a whole. Whether the producer should be worked hot or cool is a moot point. Since the coal is being carbonized in the upper part of the retort or generator, it seems unlikely that the general character of the carbonization process would be affected by the temperature of gasification in the lower part. Internal carbonization by a stream of hot gas will always tend to give prominence to the low-temperature products. The high temperature at which the coke is gasified will tend to diminish the yield of ammonia; the condition of the fuel bed approximating rather to that of the water-gas generator than the ammonia-recovery producer.

We have imagined the fuel bed as being maintained at about 1,000 deg. Cent. in the zone of vigorous gasification. By working the fuel bed at a lower temperature, the process of water-gas production would approximate more to reaction No. 3. This would involve a smaller heat absorption, and thus a smaller consumption of carbon and a smaller production of CO; for by the combustion of carbon to carbon dioxide it is necessary to consume only about one-third of the quantity to produce the same heat effect. While there is some advantage in this, and in the reduced percentage of carbon monoxide in the gas mixture made, the fuel value of the latter is lost to the gas. A greater yield of ammonia may be anticipated, and a larger yield of tar—possibly different in composition. The proportion of steam passing through the charge undecomposed would increase, and the calorific value of the gas decrease in the absence of special steps to remove carbon dioxide. The oxygen consumption per ton of coal would probably be smaller; but it seems unwise to dogmatize in advance. Altogether the conditions desirable in the fuel bed remain a problem for experimental demonstration; and there seems no advantage in complicating the calculation at this stage by assuming more than that the whole heat of carbonization and gasification is to be produced by the combustion of carbon to carbon monoxide. Some alteration in the composition of the carbon monoxide rising through the cooler layers of fuel is conceivable; but gas producer practice shows such change to be small.

The estimation of the quantity of carbon it is necessary to burn for the supply of the requisite heat can only be got indirectly, and after summing up all the items of heat expenditure. If y kg. of carbon are consumed for this purpose, it yields $1.866y$ cu. m. of carbon monoxide at N.T.P., with a mean specific heat over the range considered of 0.31 kg. cal. per cu. m. Therefore, the heat capacity at 100 deg. is $57.8y$ kg. cals. and $173.4y$ kg. cals. at 300 deg. The value of y has been deduced by finding an algebraic expression for the heat expended in carbonizing or gasifying the coal, and equating this to the heat of combustion of y kg. of carbon to carbon monoxide. By solving the equation the values of y are at once obtained. In the cases considered, carbonization with steaming and complete gasification, y has the values 6.8 kg., 36.9 kg. Hence the sensible heat of the carbon monoxide produced is 394 and 6,430 kg. cals. respectively—equivalent in heat value to 0.056 and 0.92 kg. of the raw coal respectively.

Sensible Heat of the Water Gas Made

Supposing x kg. of carbon are converted into water gas. Then x kg. carbon yield $3.73x$ cu. m. of theoretical water gas ($CO + H_2$) with a specific heat 0.31 kg. cal. per cu. m. Thus the heat capacity is $3.73 \times 31x$, or $115.5x$ kg. cals. at 100 deg. and $346.5x$ kg. cals. at 300 deg.

In the case of complete gasification, the weight of carbon converted into water gas has been arrived at as follows: The yield of coke from 100 kg. of coal is 66.4 kg. in normal practice. Deducting the 7.0 kg. of ash leaves 59.4 kg., which is taken as pure carbon. If the coke is completely gasified by a steam-oxygen mixture, the portion unconsumed by oxygen is gasified by the steam—i. e., $x = 59.4 - y$; and this was found to be 22.5 kg. The value of x when coal is carbonized with steaming was arrived at differently. It depends on the quantity of steam which may be blown into the charge. A short consideration shows that it is inevitable to carbonize with steaming, because otherwise the process would yield red-hot coke. To extract this would be practically difficult, while its heat capacity represents a considerable loss of the potential heat of the coal. Apart from steam, the only agent available for extracting heat usefully from the coke would be the cold oxygen; and owing to initiation of combustion, this would not be effective. Moreover, the thermal capacity of the oxygen would be small; and it is estimated that if no steam were used, coke at 1,000 deg. would only be reduced to a temperature of about 900 deg. Cent. when drawn (see *post*), which represents a loss of 14,050 kg. cals., or 2.0 kg. of coal. The heat of the coke can, however, be utilized in the heating of and decomposing injected steam without the expenditure of any additional proportion of the fuel value of the coal. We have calculated out how much heat in the hot coke would be available if its temperature were reduced from 1,000 to 200 deg. A portion of this would be utilized in raising the temperature of the oxygen, the quantity of which depends on the carbon consumed y; and the residue is regarded as available for heating and decom-

(*Continued on page* 11.)

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Contents of This Issue

BLEACHING OPERATIONS THAT OFFER FIELD FOR GAS—BY GILBERT C. SHADWELL 1

POSSIBILITIES OF LARGE-SCALE USE OF OXYGEN IN GAS PRODUCTION 5

EDITORIALS 9

THE COST OF SMOKE TO THE INDIVIDUAL AND THE COMMUNITY 14

NEWS OF THE GAS INDUSTRY 15

As the Journal Views It

How Different the Viewpoint

A few years ago no sophisticated young man, even in private enterprise, would have felt that he was equipped for success unless he had influence with someone high in authority.

To-day we hear very little of such rant.

Indeed, it is highly questionable if it was ever justified to any extent in any even fairly competitive business.

In a municipal, a state or a government enterprise such things are possible and actual. Such enterprises find their sustenance in taxes. And seemingly there is no limit to the resource.

But private enterprise must pay its way. Deadwood is death.

It would be all right for John Jones, shovel manufacturer, to burden down his pay roll and hamper the efficiency of his organization with a random lot of poor but genteel relations if all other manufacturers of shovels would do likewise. But in any line of industry one cannot hope not to find one grim gentleman who insists upon doing business as business, and this element is the certain deterrent at any tendency to favoritism in private enterprise.

The individual of push, ability and ambition always has had, and always will have, unless we lean too far toward community ownership, an equal chance in any competitive business. The possibility or appearance of someone else being assisted by what is known as a "pull" need not worry or discourage him.

Keeping the Stiff Upper Lip

There is nothing so demoralizing to morale as a losing fight.

Now that the skies are apparently clearing for the gas companies; now that courts and the public are beginning to manifest an ability to comprehend their financial problem, one can lean back and reflect over how the gas man has stood up under as severe a test as possibly has ever been imposed upon him.

A few years ago, when gas was pushed aside to a degree from its place as the universal illuminant, the unthinking public began to count the gas industry as a dying business.

But the unthinking public did not go as frequently into its kitchens as did the gas man; did not know so well what made the water "hot at the turn of the faucet"; was not so familiar with the changes that were taking place in the industries.

The public might well believe the gas business a dying industry. But the gas man smiled back undisturbed. He was beginning to get an insight into the possibilities of gas. He knew that the gas industry was not a business that had outlived its time, but rather one that had not yet even gotten started.

But the revelations of these last critical years jarred even the gas man's confidence; not that the gas industry might perish because it was obsolete, but by confiscation.

We have been an industry down in the mouth to an aggravated degree; an industry whose future must of necessity seem even darker than the present to those enlisted in its ranks.

A fine atmosphere surely to engender a down-in-the-mouth, listless, discouraged group of workers!

It will stand out as a remarkable tribute to the gas man's strength of will that during these trying times no such development occurred. The gas man remained true to his ideal of public service, and, thought he might have questioned "What's the use?" did not falter in the full discharge of his duties.

Interesting to Have Their Viewpoint

We have an acquaintance who is a decorator. We had him do a small job and saw little reason, as reflected by his bill, why *he* should grumble at high prices.

But he does and bitterly.

He pointed to a wall that to us did not appear to have outlived its attractiveness.

"See that?" he demanded. "A few years ago would you have tolerated it? Of course you wouldn't, not when the mere painting a wall represented so small a charge that even a few inconspicuous spots that a chance caller would not have detected, would have made it seem unbearably soiled to you. But now the painting of a wall is looked upon almost as seriously as an investment. You must have a really substantial reason before you buy. People are merely patching now. Those who a few years ago wouldn't have the decorators in except to go over the whole house, now get them in for a single room. Many had the whole house done every year. Nowadays when we do a few rooms we chalk that patron off our prospect list indefinitely. It may be several years before we come back. At best it will not be less than two.

"I'm busy you say? It takes me weeks to get around to your work? That doesn't mean I'm prosperous. I've done more running about these last two years, been more on the job, than I was in the previous ten, but I'm not doing a fifth as much."

Somewhat curiously we encountered one of his workers on the street car that evening.

"You're lucky you've had your work done," he informed us. "Wages are going up again."

We expressed surprise, informed him we understood orders were slack in the decorating field.

"Your boss," we finished up as a clincher, "isn't doing near as much as he did two years ago."

He grinned.

"That's what a couple of them said," he retorted. "Said we'd put costs up so high people would stop decorating. But the fact remains there's half a dozen bosses got calls in for men down at the union headquarters."

To him who stops to reason it is quite clear that the wage receiving branch of the decorating industry, just as with railway workers, gas company workers, barbers and so on indefinitely, are paving the way to curtailment of employment over a long and trying period, and they have no more idea of what they are doing than has the average small boy who essays to improve the working of his father's watch.

At all times there was plenty of amply-paid work for decorators, because people were almost extravagant in having work done.

It was taken almost as a matter of course that it was necessary to our contentment of mind to have the colors changed every now and then, even when, perhaps, as a plain matter of course the changes were not necessary at all.

People are practising at looking upon decoration from the point of view of upkeep alone. The fad element for the time being is forgotten. Let this attitude of mind become fixed and the population may be doubled before there is as much decorating done again as was done in the old days.

Just now in the press to catch up with the gap left by wartime the effects of this attitude are not felt. To meet upkeep alone requires more decorating than there are decorators available.

But this is a well that will run dry. And the wage-earning decorators by their bull-headed efforts to get all the traffic will bear are doing their utmost to fix the upkeep attitude permanently in the minds of the Amer-

ican people. Once stamped there, even a drop in prices will not change things and bring back an abundance of work.

Figuring in its influence on cost of raw materials as well as actual operations, labor constitutes a most important factor in the cost of gas. And the cost of gas, if it was generally met with equitable rates, would be approaching that point where people will think before turning the stop-cock.

No one, least of all the AMERICAN GAS ENGINEERING JOURNAL, begrudges the gas company wage-earner an ample and liberal compensation. His is an arduous and oftentimes hazardous form of labor. And primarily a man must live and be able to put something aside for the time when his ability to labor is impaired by age. But let the gas worker base his wage demands on reason. Let him subject them to the judgment of his manager, for in ninety-nine cases out of a hundred his manager will advise him from the basis of justice even when that seems to carry the wage beyond the company's ability to pay. Let the gas company worker not, like the decorator, for example, kill the goose that lays the golden egg.

We must be able to live and to buy food and clothing to-morrow as well as to-day.

Possibilities of Large-Scale Use of Oxygen in Gas Production

(*Continued from page* 6.)

posing steam with attendant gasification of a portion of the coke. In this way we have to ascertain x and y, which can vary simultaneously. Two equations are deduced which give the value as $x = 3.94$ kg. coal, $y = 6.8$ kg., respectively. Hence the heat capacity of the water gas, $115.5x$ kg. cals., is equivalent to 0.065 kg. of coal.

HEAT CARRIED OUT OF THE BOTTOM OF THE PLANT IN COKE OR ASH

If the coke is completely gasified, there is left to be discharged only the 7 kg. of ash. If the gasification be carried out under producer conditions, this may be regarded as discharged into a water lute at a temperature certainly not above 100 deg. Cent. Assuming a specific heat of 0.25, which is an average value for clays and sands, the heat capacity becomes equal to 175 kg. cals., equivalent to 0.025 kg. coal. This is an almost negligibly small quantity, and indicates that a high ash content of the coal has little effect on the thermal balance sheet for complete gasification. There are, of course, other objections to high ash. In carbonization, sufficient steam is supposed to be blown into the charge to reduce the temperature of the coke to 200 deg. Cent. Taking the specific heats of carbon and permanent gas as $0.2142 + 0.000166t$ per kg. and 0.31 per cu. m., respectively, the heat capacity of the coke finally discharged becomes $0.47 - 0.0071y - 0.0071x$, equivalent to 0.38 kg. of coal.

It is much more difficult to evaluate this source of loss, and the experimental information is meager. It seems to have been usual in making thermal balance sheets to put all the errors of measurement under the heading conduction and radiation, arriving thereby at a result which is obviously much in excess of the truth. Euchene and Barnum made direct measurements on the loss by radiation, etc., of a horizontal retort setting, and obtained results which we estimate at 3.4 per cent, 3.2 per cent, 3.0 per cent, 3.6 per cent and 1.7 per cent of the heating value of the coal carbonized, the mean being 3 per cent. Here the coal during the carbonization by external heat is enclosed by a bulky mass of brickwork at a considerably higher temperature. Clearly, the heat loss under this heading will be on a very much reduced scale when the coal is carbonized by internal heat. The hot charge being enclosed in a cool shell, the conditions are more analogous to producer practice; but even there the direct experimental evidence is very meager. Glasgow obtained, by direct measurement on a water-gas generator, a figure which we estimate to be 1.22 per cent on the heating power of the fuel gasified.

We have thought it advisable to calculate the heat loss on various assumptions which seem reasonable. We have assumed the loss as equivalent to that by radiation, conduction and convection of a cylinder 10 ft. internal diameter, 11 ft. in internal height, closed top and bottom, and lined with 13½ in. of brickwork. The fuel bed is assumed to be 8 ft. deep. The producer has then an external exposed surface of 746 sq. ft., of which 469 sq. ft. is below the top of the fuel bed. The heat loss per hour has been estimated in three different ways: (1) By calculating how much heat could be transmitted by the brickwork lining per hour; (2) by calculating how much heat would be lost to the air by the external surface, on the basis of empirical factors; (3) by calculating the heat which it would radiate, on the assumption of Stefan's law.

1. For this purpose the internal temperatures were assumed to be 300 deg. Cent. above the fuel bed, increasing to 1,000 deg. at the base. The external temperatures corresponding were assumed to be 50 and 100 deg., with a mean difference across the brickwork of 250 deg. above and 600 deg. below the fuel bed. Assuming a conductivity of 0.003 in C. G. S. units for the brickwork, the hourly transmission worked out to 58,000 kg. cals. below and 12,680 kg. cals. above the fuel bed; in all, 70,000 kg. cals., or 10 kg. of the coal per hour. If the producer were gasifying 12 tons of coal per day (or about 500 kg. per hour), this heat loss would amount to 2 per cent—i. e., 2 kg. on the 100 kg. of coal treated.

2. Certain empirical factors have been determined from time to time for use in estimating the heat losses of surfaces. Dougill made determinations of these factors which were based on the heat losses of gas-works' air condensers. Using his results as a basis, the heat lost per hour by the 277 sq. ft. at 50 deg. Cent. above the fuel bed was calculated as 4,530 kg. cals. and 26,000 kg. cals. for the 469 sq. ft. below the fuel bed at a temperature of 100 deg. Cent. The total is 30,530 kg. cals., or 4.36 kg. of the coal gasified at the assumed rate of 500 kg. per hour—i. e., 0.87 per cent of the coal put through.

3. By the simple application of Stefan's law to the radiation of a black body surface, of the area and temperatures assumed, the hourly heat loss works out as 39,000 kg. cals., or 5.6 kg. of coal, which is 1.12 per cent on the hourly throughput. (This assumes black-body conditions and neglects convection loss.)

The percentage loss through the walls, as estimated in three different ways, is, therefore, 2, 0.87 and 1.12

per cent. There are good grounds for regarding the first figure as being altogether too high, apart from Glasgow's positive result.

The lining of the producer is not an unbroken mass of refractory material, as assumed in the calculation. It contains joints and air spaces which have been shown by Dougill, Hodsman and Cobb to have a conductivity roughly one-tenth of that of the solid brick. Furthermore, if it became a matter of importance the heat loss could be reduced by lagging the producer with a non-conducting layer. In existing practice, where such losses are negligible, no serious attempt is made to reduce them to minimum proportions. We consider that, on the whole, there should be no difficulty in complete gasification bringing this loss down to less than 1 per cent of the fuel treated; and this figure, which harmonizes with the figures obtained by methods 2 and 3, has been used in this calculation.

The loss should be relatively smaller in a carbonization process, as the coal would pass through the plant two or three times as fast. Thus the loss through the walls might fall as low as 0.33 per cent; but we have preferred to assume it as halved only, taking it as 0.5 per cent.

Expansion Work

There is a small expenditure of heat in performing the external work of expansion. It is entirely negligible compared with the heat losses of existing practice, and may be regarded as recovered later. But it merits attention when considering the minimum possible losses and heat requirements. When coal is carbonized or gasified, there is a large increase in volume of the system, owing to the evolution of the gas from a solid. The process in this respect is analogous to an expansion of gas under constant pressure, in which the gas does work in displacing the atmosphere. The product of the pressure and volume increase gives a measure of this work, and this equals in calorific units per gram molecule 1.98 $\times$ the absolute temperature. The expansion may be considered as resulting from the escape of the gas at 0 deg. Cent. from a solid, followed by expansion on being heated to the temperature of egress from the plant. The latter item is allowed for in the specific heats at the constant pressure used in estimating the sensible heat of the gases. So we are concerned only with the former. The external work is, therefore, 1.98 $\times$ 273 = calories per gram molecular volume at 0 deg. Cent.

Due to the formation of carbon monoxide, we have an expansion of 0.933 cu. m. per kilogram of carbon oxidized, and 1.866 cu. m. per kilogram due to the formation of water gas from carbon. In addition, there is the expansion due to the evolution of 27 cu. m. of straight coal gas.

The item on the 100 kg. of coal treated worked out to 0.15 kg. of coal for carbonization with steam and 0.355 kg. for complete gasification.

Heat Expended in the Form of Water Gas

For this purpose we have assumed, as a first approximation, that the reaction is of the simplest type, $C + H_2O = CO + H_2 - 29{,}000$ cals.—i. e., neglecting adjustment to equilibrium, which will not greatly modify the end result of the calculation. The heat absorption amounts, therefore, to 2,417 kg. cals. per kilogram of carbon gasified—equivalent to 0.345 kg. of the coal. In complete gasification we saw that 22.5 of carbon went to form water gas; and hence the heat absorption corresponding is equal to 0.345 $\times$ 22.5 = 7.75 kg. of coal.

It is to be noted that heat expended under this heading differs from that under the first four items, which represent total thermal loss. While heat expended under the fifth item has to be compensated by the combusion of an equivalent of carbon to carbon monoxide, the fuel value of the carbon is not thereby lost but is replaced by the formation of a combustible gas mixture. The heat expended in water-gas formation must, however, be ascertained to determine the quantity of carbon to be burned in the gasification process for supplying the requisite heat. No allowance is made for water-gas formation in carbonization, even when steam is used, as the latter is taken in such quantity as can be decomposed by the sensible heat of the coke. It is not, therefore, a further charge in the heat supply by combustion. If the water-gas reaction led to the formation of carbon dioxide instead of carbon monoxide, the quantity of carbon necessarily burned would be much less, but the fuel value of the carbon monoxide would be lost.

Having arrived at the various heat losses, and the quantity of carbon which must be consumed to provide the necessary heat, it is now possible to estimate the volume, composition and calorific value of the gas produced—assuming it to be a mixture of the original straight gas with the calculated quantity of carbon monoxide and water gas. Then a heat balance can be worked out for each case and an estimate of the thermal efficiency of the processes. Lastly, the quantity of oxygen and steam required for the purpose can be deduced. These are collected in Table I. The definition of efficiency of gas production given by Clerk, Smithells and Cobb in their report, entitled "Coal, Gas and Electrical Supply Industries," has been used here—viz., the ratio of the heat carried by the gas to the heat which it carries *plus* the heat cost of carbonization or gasification, these heat costs having been calculated in the manner described.

Several conclusions follow at once from a perusal of these results. The unavoidable thermal losses either in carbonizing or completely gasifying coal with oxygen and steam are evidently relatively small, and the thermal efficiencies correspondingly high. Of the individual losses, the sensible heat of the water vapor is considerable; and on this account excessive moisture, when internal heating is practised, would be objectionable. The heat in the hot coke would also be a serious item of loss if not utilized as by steaming. Some additional fuel is necessary to raise the requisite steam. But economy results, and steaming seems to be an essential feature of either the carbonization or gasification process by internal heating with oxygen. Another noticeable and important feature is the very high thermal efficiency of the processes, regarded solely as gas manufacturing operations. The expenditure of heat obtained by these calculations has been used for calculating the thermal efficiency, and not the difference between the thermal yield and 100, which would include the thermal loss already made in the original carbonization results which form the basis of the calculations. The heat of formation of water gas has not been classed as a heat loss (although it required the consumption of an equivalent of carbon), as it is recovered in the fuel value of the gas produced. Carbonization with steam would apparently enable nearly one-third of the heating power of the coal to be carried by a gas (29,000

cu. ft. per ton of a gas of 427 B.t.u. gross) containing but little inert constituents while still leaving half a ton of coke, the ash content of which would be somewhat but not greatly increased. If the gasification were carried to completion, it appears that about 95 per cent of the calorific value of the coal could be recovered and about 90 per cent after allowing for the steam, 86 per cent of this being in the gas—69,100 cu. ft. of gas of 352 B.t.u. per cubic foot. The smallness of the heat lost in the ash shows that high ash content in inferior coals would not seriously influence the thermal balance sheet. Inferior non-coking fuels would be adapted to gasification, while the higher qualities could be reserved for carbonization.

The results are remarkable; and if they are technically possible, and now or in the future commercially realizable, new possibilities appear in the distribution of both heat and power. The practicability can only be solved by actual experimental trial, although there is no reason to presuppose the contrary. The commercial feasibility has hitherto been out of the question; but there are grounds for believing that it is not now to be ruled out. It hinges, in the first place, upon the cost of oxygen. The quantities of oxygen required are, however, relatively small in comparison with the volume of gas produced. Furthermore, the cost of oxygen as handled hitherto in commerce is no determinant of what may be attained in the near future. The industry of the separation of air into its constituents has not yet arrived at maturity. According to an advertised statement, the total daily production of oxygen in this country is only about 1,500,000 cu. ft.—the output of a modest city gas works—while theory and experience indicate that air separation processes are cheapened as the scale of operation is increased.

Thus we are informed privately that oxygen can be made in a plant producing 100,000 cu. ft. in twenty-four hours, at 12s. 6d. per 1,000 cu. ft.—a prohibitive price for our own purpose. Yet, before the war Claude contemplated the possibility of producing oxygen at 6d. per 1,000 cu. ft. under ideal conditions on a very large scale. The separation of oxygen from air can be theoretically effected by a relatively small expenditure of energy—about 2¾ hp.-hr. per 1,000 cu. ft. Hitherto this ideal has not been approached in practice; but the necessary conditions being realized, it seems certain that a very much closer approximation to the ideal will be attained. As the size of plant increases, the power consumption relatively diminishes, as is to be expected in a process where efficient exchange of heat at a low temperature is so important.

It seems probable that if oxygen could be manufactured on the same scale as town gas, similar or lower figures of cost would be attainable. Hitherto the volume scale of manufacture has been that of the village gas works. The cost is discussed in the report of the Nitrogen Products Committee (Ministry of Munitions) recently published, and the opinion is given that the running costs of a plant making 24,000 cu. ft. of oxygen (98 per cent) per hour are 10d. to 12d. per 1,000 cu. ft., and that "a safe maximum for plant producing nitrogen—power and depreciation included—is 6d. per 1,000 cu. ft. of nitrogen, ignoring the value of the oxygen." This estimate is only relatively optimistic. The United States Bureau of Mines has been interested in experiments on a development of air separation, from which even lower costs are anticipated. This is the Jefferies-Norton system, which has been tried on a large scale during the war, for separating 0.05 to 1 per cent of helium for proposed use in airships from certain natural gases in Texas—an extremely severe problem in gas fractionation. In a private communication F. E. Norton informs us that the results obtained in the separation of helium show that a plant making 24,000 cu. ft. per hour would produce oxygen at 30 cents per 1,000 cu. ft. He anticipates, however, that a plant of tenfold capacity would produce at 5 cents per 1,000 cu. ft.—the interest and depreciation charge being then the main item of cost.

There are thus grounds for believing that in the future the cost of oxygen will not be an obstacle to its use in gas-making processes, and that its cost in carbonizing or gasifying a ton of coal, as calculated above, would be small. These costs are tabulated in Table II from the results of Table I. In comparing the oxygen process with normal carbonization and gasification practice using air, it must be remembered that, apart from the saving of fuel, the cost of the plant for carbonizing should be greatly reduced both absolutely and relatively to the tonnage of coal treated; for the speed of carbonization by internal heat should exceed that of normal practice. Thus the fixed as well as the running costs of gas making should be reduced.

TABLE II

FOR CARBONIZATION

	Cost of Oxygen in Pence
Price of oxygen per 1,000 cu. ft.—12s. 6d.:	
Per ton coal	342.0
Per 1,000 cu. ft. gas	16.0
Per 100,000 B.t.u. in gas	3.75
Price of oxygen per 1,000 cu. ft.—1s. 3d.:	
Per ton coal	34.2
Per 1,000 cu. ft. gas	1.6
Per 100,000 B.t.u. in gas	0.37
Price of oxygen per 1,000 cu. ft.—10d.:	
Per ton coal	22.8
Per 1,000 cu. ft. gas	1.06
Per 100,000 B.t.u. in gas	0.24
Price of oxygen per 1,000 cu. ft.—2½d.:	
Per ton coal	5.7
Per 1,000 cu. ft. gas	0.26
Per 100,000 B.t.u. in gas	0.06

FOR COMPLETE GASIFICATION

Price of oxygen per 1,000 cu. ft.—12s. 6d.:	
Per ton coal	1,850.0
Per 1,000 cu. ft. gas	27.0
Per 100,000 B.t.u. in gas	7.6
Price of oxygen per 1,000 cu. ft.—1s. 3d.:	
Per ton coal	185.0
Per 1,000 cu. ft. gas	2.7
Per 100,000 B.t.u. in gas	0.76
Price of oxygen per 1,000 cu. ft.—10d.:	
Per ton coal	124.0
Per 1,000 cu. ft. gas	1.8
Per 100,000 B.t.u. in gas	0.51
Price of oxygen per 1,000 cu. ft.—2½d.	
Per ton coal	31.0
Per 1,000 cu. ft. gas	0.45
Per 100,000 B.t.u. in gas	0.13

All evidence agrees that, if maximum economy is to be secured, the separation of oxygen from the air must be done on a large, continuous scale. At present it is both made and used on a relatively small scale. In few

places is there now opportunity for the really large, steady consumption essential to cheap production. An attempt was made before the war to create one by the use of oxygen for enriching the air supply of an iron blast furnace at Ougree-Marihaye, in Belgium. The preliminary note of the experiments has not been followed by more detailed results—doubtless owing to the intervention of war. In America the application to metallurgical practice is being closely examined with the assistance of the United States Bureau of Mines. But if the gas-making processes outlined above can be shown to be technically and commercially feasible, the gas industry itself could offer scope for large, steady consumptions of oxygen, which would provide just the conditions conducive to cheap production.

The Cost of Smoke to the Individual and the Community

The smoke nuisance is closely related to fuel efficiency. Excessive smoke indicates that the best efficiency is not being obtained, but at the same time a stack which is perfectly clear all the time indicates the probability of low efficiency. The combustion may be complete, but a large amount of excess air is being heated instead of the heat being applied to the purpose intended.

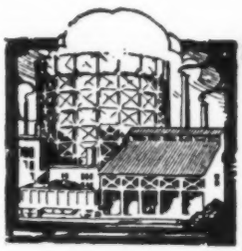
In almost all cases, reduction of smoke results in increased efficiency, due to the fact that greater attention is paid to the design of the furnace, to its proper maintenance, and to its skillful operation.

I will dwell for a minute or two on smoke abatement from the standpoint of conservation, and safety engineering includes conservation of human health and strength, declared E. P. Roberts in a paper before the Western Pennsylvania Division of the National Safety Council at Pittsburgh. Before deciding whether or not this subject is worth considering, we should have some idea as to its importance, and from the standpoint of money the importance of smoke abatement is seldom appreciated, though it has been frequently stated. As stated before, smoke abatement practically always results in fuel conservation, usually not less than 10 per cent and frequently 20 or 30 per cent. In addition, smoke is injurious to health and therefore the working capacity of everyone living in a community where bituminous coal is the principal fuel is reduced, and doctors' and hospital bills are increased. This applies not only to the worker but also to the children and the not yet born. Smoke is injurious to plant life. This is a well-known fact, and we cannot evaluate the decreased beauty of the city; nevertheless, anything which tends to lessen the pleasure of life also tends to increase grouchiness and physical condition, and there is an old saying, "Living depends upon the liver." To have maximum production we must have maximum health.

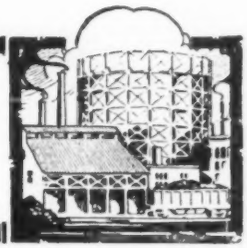
Damage Cost to Community $1.50 a Ton

Relative to the economic waste, there have been numerous reports. The report made by the Chamber of Commerce Committee of Cleveland in 1911, of which committee I was chairman, stated that the maximum loss in Cleveland was not less than $12 per capita and not unlikely twice that amount. At that time the population of Cleveland was approximately 500,000. The Mellon Institute in Bulletin No. 5, printed in 1913, states a damage in Pittsburgh of approximately $10,000,000, based on the cost to the individual, the cost to the household, the cost to the wholesale and retail stores and to public buildings. Ascertaining the damage per ton of bituminous coal used, the Cleveland report shows $1.50 per ton and the Pittsburgh report $1.25 per ton; and you all know that all the items used in making such estimates, such as painting houses, etc., have been doubled or trebled in cost. It is probably ultra-conservative to state that the damage per ton of bituminous coal in a city having a fair degree of smoke abatement is not less than $1 and not unlikely materially more, and that the per capita loss is not less than $7 or $8 per year and not unlikely two or three times as much. Considering all these things, is it not worth while, from the standpoint of the maker of smoke and also from the standpoint of the unwilling consumer, to use every effort to obtain increased efficiency by the use of fuel and the lessening of the smoke nuisance?

In conclusion, how may we obtain this result? As citizens of the community we can work individually, but we can do better work by joining such association as is especially competent to give publicity as to the importance of smoke abatement and fuel conservation, and to assist in providing adequate funds, and who will follow up the work of the city smoke department. In this connection I suggest that each organization interested in civic improvement have a smoke committee and that such committee give special attention to such phases of the work as they are most competent to understand and as to which they can be most helpful. The engineering society could keep the matter before the engineers and be able to state whether or not the smoke department is well informed, is reasonable, and is doing its duty. In this connection it might be noted that technical men in public employ are frequently damned by those who are not competent to understand the problem and are seldom praised, and if they are the same is true that the persons giving such praise are not competent to consider the problem on which they have passed judgment. The competent technical man desires not only to have a living wage but in some respects, even more important, he desires professional recognition and in most cases such men have no incentive from the professional standpoint. Other phases of the work can be taken care of by other organizations, including providing money, publicity, etc.; and the various committees, or at least their chairmen, can have three or four joint meetings annually and give publicity to their findings. In some cities, and I believe in Pittsburgh, good results have been obtained, but the best will not be obtained without sufficient money, competent men, a "follow-up" system, and giving publicity to the results, whether same are bad or good. A few cities have, considering the money appropriated, well-conducted smoke departments, while those of others might be considered, if it were not for the seriousness and importance of the problem, as jokes.



NEWS OF THE GAS INDUSTRY



$1 Gas Ordered by U. S. Courts for New York

Kings County Lighting Company Also Granted Temporary Restraining Order Against the 80-cent Gas Law

Dollar gas has been become a reality in New York City.

Until the final determination of the rate litigation between the Consolidated Gas Company and the State and county authorities and the Public Service Commission, now pending in the United States District Court, to declare the 80-cent gas law of 1906 confiscatory and unconstitutional the Consolidated and its subsidiaries will be allowed to charge, beginning July 1, not exceeding $1 per 1,000 cu. ft. They are granted this permission in eight injunction orders filed by Federal Judges H. G. Ward, John C. Knox and W. I. Grubb.

Richard Wellington is appointed special master to hold the difference between receipts at the 80-cent and the newly authorized $1 rate for ultimate disposition, according to the determination of the main suit. If this suit results in a victory for the consumers, represented by the municipal authorities, the difference will be refunded; if a victory for the gas companies the moneys so held will be turned over to them. The New York Trust Company, the United States Mortgage & Trust Company, and the Title Guarantee & Trust Company are made depositories of the fund, a verified statement of which shall be made by the companies to Mr. Wellington on Aug. 15, and the fifteenth day of each month thereafter.

Referring to the recent findings of Special Master A. S. Gilbert, in which he recommends to Federal Judge Julius M. Mayer that the statute of 1906, fixing the 80-cent rate, be declared in contravention of Article I of the Fourteenth Amendment of the Constitution, the court said:

"We have not to fix a rate, but to determine if the statutory rate is void because confiscatory; and, if so, to give the plaintiff the protection which it ought to have against confiscation pending final judgment."

Old Rate Held Confiscatory

Adverting to the affidavits of the Consolidated, covering its items of expense for operation for the year 1919, as an independent concern, and its expenses for the same year in combination with its subsidiary corporations, the decision holds that the evidence satisfies the court "that the plaintiff is not now and has not been able during 1919 and will not be able in the future to manufacture and sell gas at the statutory rate of 80 cents with anything left for a return upon its investment. We think the rate is confiscatory."

Taking up the several legal objections against such a holding, the court goes on to say:

"It is suggested that a period of experimentation has now elapsed sufficient for us to say as to whether the 80-cent rate is confiscatory. We think it is quite sufficient. What the plaintiff (the Consolidated) may earn by reason of its interest in companies engaged in selling electric current is not to be considered in determining what is a fair return on its gas business. The two operations are entirely distinct, and we suppose it would be hardly contended that if the plaintiff lost money in its electric business a fair rate of return for its gas business should be raised to cover that loss."

Answering the objection of the defendants that the gas companies are not entitled to relief because they have not furnished gas of the candle power required by the statute, the court says:

"The special master has found that this is not the fact. But, if it were, it would be no justification for confiscation of the plaintiff's property. Public officials have taken no action to enforce compliance with this requirement.

"We are convinced that a charge of $1 per 1,000 cu. ft. of gas will leave the plaintiff a moderate return upon its investment. Therefore the preliminary injunction will be granted upon condition that it charge not more than the $1 rate."

The injunctive orders in the applications of the Consolidated's subsidiary companies—the Central Union Gas Company, East River Gas Company, New Amsterdam Gas Company, New Mutual Gas Light Company, Northern Union Gas Company, and the Standard Gas Light Company, make the same provisions.

Applies to Kings County Company

The Kings County Lighting Company, Brooklyn, N. Y., an independent concern, which also petitioned for an injunction against the State and county authorities and the Public Service Commission, and which supplies gas to the Thirtieth and Thirty-first Wards of Brooklyn, also was awarded a temporary restraining order against the enforcement of the 80-cent gas law on the same terms.

The first injunction restraining the municipal authorities from enforcing the statute of 1906 was granted to the Brooklyn Union Gas Company several months ago, since which time it has been charging 97 cents.

Commenting on the court's decision, Robert E. Livingston, of the Consolidated Gas Company, said about 350,000 automatic meters now adjusted to the 80-cent rate will have to be changed to the $1 schedule. The July gas bills, he said, will show the 80-cent charge, and the charge

under the new schedule after July 1. He also said that, owing to the loss of at least $2,000,000 by the Consolidated in 1919, due to the increased cost of labor and material, a reasonable return on the company's investment would be a rate of $1.25 to $1.30 per 1,000 cu. ft.

This temporary victory of the gas companies is an incident of litigation which has been going on for a year and which will now be pressed to a conclusion as speedily as possible. The object of the gas companies is to have the 80-cent gas law of 1906 permanently set aside.

The Southern Gas Association Holds Successful Convention at Norfolk

The twelfth annual conventtion of the Southern Gas Association was held at Norfolk, Va., June 22 to 24. Mayor Albert L. Roper in an eloquent address of welcome turned over the keys of Norfolk to the two hundred delegates who gathered at the opening session.

The first morning's program was devoted to a short business session presided over by Noble Clay of Winston-Salem, N. C., president of the association, followed by a discussion and three interesting papers on subjects of a technical character relative to the gas industry. Mr. J. A. Forney, Charlotte, N. C., paper: "Can Appliance Sales Department Be Made a Paying Department in the Gas Companies?" Dr. J. A. Callenbach, Ph.D., M.E., Norfolk, paper on "Coal." Mr. Louis Stotz, address: "Work A. G. A. Is Carrying On."

In the afternoon the delegates were taken for an automobile trip to points of interest about the city. At the Naval Base a dress parade was staged for the benefit of the visitors. Many of the delegates being from inland cities, the scenery of this locality was of particular interest, as were the sights at the Naval Base. Following the automobile trip, the delegates scattered in search of further diversions. Some were entertained at the various clubs of the city; others sought recreation on the golf links of the Country Club.

In the evening a buffet supper was served in the Chamber of Commerce club rooms followed by a paper by J. G. Thomas, "Precision Patent Calorgraph" and a discussion of rates.

Wednesday morning all were taken for a trip about the harbor to places of interest including Old Point, Norfolk and Western coal piers, and the Newport News Shipbuilding and Drydock Company. A business meeting was held aboard the boat at which Mr. Judson C. Dickerman, Engineer State Corporation Commission, Commonwealth of Virginia, read his paper, entitled "Some Readjustments in the Gas Industry Now Apparently Necessary," and Dr. T. E. Green, American Red Cross, Division of Speaker's Bureau, Washington, D. C., addressed the meeting.

In the evening the annual banquet was held at the Monticello. Joe D. Taylor was toastmaster and Hon. Fletcher W. Stites spoke on "The Building of a Republic." Dancing followed in the grand ballroom.

Thursday morning the Navy Yard was visited and in the afternoon the final business session was held at the Cape Henry Casino. Officers and directors elected for the coming year are: President, E. C. Stothart, Charleston, S. C.; first vice-president, J. A. Forney, Charlotte, N. C.; second vice-president, J. C. Nichols, Bluefield, Va.; secretary, George H. Smith, Norfolk, Va. The directors are Joe Taylor, C. H. Harriman, E. D. V. Dickey, and J. W. Kerson. The 1921 convention will be held at Savannah, Ga.

Bridgeport Gas Company Announces Rate Increase

An increase of two cents a hundred, or 20 cents a 1,000 cu. ft. of gas effectual on bills rendered on and after July 1, has been announced by the Bridgeport Gas Light Company, due, it was stated, to the increased cost of materials and labor. Gas will hereafter be charged at the rate of 14 cents per 100 cu. ft. and within a 10-day discount period designated on the bills payment will be accepted at the new rate of 13 cents per 100 cu. ft.

It was also announced that each meter through which the consumption is less than 400 cu. ft. per month will be subject to a minimum net charge of 50 cents per month.

Quantity discount of five cents per 1,000 will be allowed on monthly consumption in excess of 25,000 cu. ft. and on all over 100,000 cu. ft. per month a further discount of five cents per 1,000 ft. will be allowed.

N. J. Utilities Commission Denies Gas Rate Based on Oil Price

Declaring that a proposed amended rate of the Public Service Gas Company, Newark, N. J., was unjust and unreasonable, the Public Utilities Commission announced recently that it disapproved of the rate. The company proposed to amend its schedules of rates as follows: An addition or deduction of one cent per 1,000 cu. ft. for each thirty-three-hundredths cents per gallon of increase or decrease from an average cost of five and eighteen hundredths cents per gallon for gas oil received at the plants of the company during any month, this clause to be applied to the schedule of rates as filed with the Public Utilities Commission on June 24, 1919, and approved November 18, 1919, and to become effective to all consumers with June sales, 1920.

Testimony was submitted at a hearing in the matter of increase before the commission showing a growing scarcity and consequent mounting cost of gas oil. It was also shown that the company was being served with oil under a contract, which terminates on or about August 1 next; that the company does not anticipate that it be able to make a new contract because of existing conditions and that it will be required to purchase its oil in the open market at varying prices in competition with other users. It therefore proposed to vary the rate at present charged, as fixed by the commission in a recent investigation, to meet the price of oil as it fluctuates from the price at which it was purchasing it when the rate was fixed.

The commission stated in a report on its decision in the case that "the uncertainty both as to the supply and price of gas oil is too well known to require discussion. It is manifest that the existing and future conditions are uncertain. The cost of manufacture per thousand was ascertained in the original investigation of the rates in which the rate was fixed by this board at ninety cents per 1,000 cu. ft. When the present rate was fixed it was ascertained by merely adding the known increased costs over those in the former case. Oil is one of the large factors in the manufacture of gas, and, with the base already found and used by the board

in the former cases, any fluctuation in the price thereof from the last base price used could be applied either upward or downward. A varying price would result. In theory such a method would appear to be sound. The resulting uncertainty to the consumer as to the prices to be charged would, however, make it impractical and probably cause much confusion and annoyance. The board has found that general dissatisfaction arises from the application of variable rates. People generally prefer to know exactly what the rate will be. It is also desirable that when a rate is fixed it should remain in effect, independent of temporary fluctuations in operating costs, and should not be changed, because of such fluctuations unless it appears that to maintain the rate would work an injustice either to the public or the utility.

Wisconsin Gas Association Favors Reduction of Gas Standards

Application has been made to the Railroad Commission by the Wisconsin Gas Association for a reduction in the heating value standards for gas, on the ground of increasing difficulty in obtaining oil and coal entering into gas manufacture. It is proposed that the present Wisconsin standard of 600 B.t.u. per cubic foot, established in 1913, be lowered to a monthly average of 520 B.t.u.'s, with 500 as the minimum and 540 as the maximum.

Joining in the application are all gas companies in Wisconsin, numbering about 30. The petition was filed by a special committee headed by R. B. Brown of the Milwaukee Gas Light Company.

A similar attitude toward existing standards has been taken by the American Gas Association, which has passed resolutions protesting against present high heating values as being wasteful of oil and coal at a time when conservation is of vital importance to all industries.

The gas companies of Wisconsin, in an exhaustive review of the situation, cite grave operating difficulties as justification for the proposed change. Decreased supply of fuel and increased demand for gas, an almost unlimited demand for gasoline, and the use in newer processes of gasoline manufacture of residue formerly utilized in gas making, thus depriving the gas industry of this raw material, are the principal factors entering into the companies' complaint. Use of heavier oils in the manufacturing process is declared impracticable.

Other obstacles cited are the great difficulty in obtaining gas coals in sufficient quantity, the excessive cost of and delays involved in installing coal gas equipment, and the inferior quality of gas coals. The oil process of manufacture is the most generally employed.

The petition protests against the Wisconsin standard of 600 B.t.u. as an unreasonable requirement, even when it was first made in 1913. It proceeds to compare this standard with lower heating values elsewhere, such as Canada, where the standard is 450; New England, 528; England, with various standards under 500, and many other States of the Union where 565 has been generally employed. Several of these States are said to be considering much lower standards.

The gas operators expressed no fear of adverse effects on consumers, declaring that at Toronto, where the heating value was gradually reduced from 575 to 475, the average domestic consumer's bill had not increased, and that New England cities had the same experience.

"In any event," the petition declares, "the question of cost becomes secondary at this time to the question of ability to obtain materials in quantity and quality to maintain the present standard."

Wakefield Gas Rate Up

The gas rate in Wakefield, Mass., has been advanced from $1.60 to $2 per 1,000 cu. ft. with a discount of 20 cents for prompt payment, making a net increase of 20 cents a thousand.

American Gas & Electric Company, New York, declared an extra dividend of 2 per cent on the common stock, payable in common stock and regular quarterly dividend of 1½ per cent on the preferred stock. Common is payable July 1 to stock of record June 18 and the preferred Aug. 2 to stock of record July 15.

Kansas City Company Granted Increased Rates

The State Public Service Commission of Kansas in granting increased rates to the Consolidated Gas Company of Kansas City issued the following statement:

"The value of the property of consolidated company is tentatively fixed at $9,700,000, this being the same value fixed by the commission when it authorized the consolidation of the two companies and the capitalization by the consolidated company in the amount of $9,556,500.

"The commission authorizes the gas company to pay the receiver of the Kansas Natural Gas Company the rate of 35 cents per 1,000 cu. ft. for natural gas at the city gates as ordered by Judge Booth of the Federal court, the commission finding that this rate is reasonable and necessary to enable Kansas City to secure an adequate supply of natural gas.

"The commission authorizes the gas company to put in for a temporary period of thirteen months from July 1, in addition to the present rate of 80 cents per 1,000 cu. ft. for natural gas, monthly service charges depending on size of meters used as follows:

Hourly cu. ft. cap. of meters	Service charge
90	$ .50
140	.75
230	1.00
375	1.25
475	1.50
Over	ratably

"The commission found, according to the report, that 88 per cent of the company's domestic consumers would pay the smallest service charge of 50 cents per month; that the service charge was necessary to enable the company to meet the increased cost of gas at the city gates fixed by the Federal court, and that with the new service charges the company will make 6.4 per cent per annum on the depreciated value of its property fixed by the commission.

"The company is required to file sworn quarterly reports with the commission, showing its revenues and expenses, and the commission retains jurisdiction to change the rates at any time in accordance with changed conditions."

Oil Shortage and the Gas Industry

Referring recently to the available supply of petroleum in this country and its most necessary uses, an official of the United States Geological Survey spoke of the difficulties encountered by the manufacturers of gas in obtaining the needed supply of oil, and added that in the not distant future the public must determine what are "the most essential uses of petroleum products." The gas manufacturers are among our heaviest consumers of oil. They use annually from 24,000,000 to 26,000,000 barrels. The wide public interest in this comes from the fact that gas made from this oil serves about 30,000,000 people of all parts of the United States.

In the *Chemical Age* Oscar H. Fogg, secretary-manager of the American Gas Association, says that the introduction of the water-gas process brought about the use of oil in gas manufacture. It was found that this combination developed a new process which was more flexible and less expensive than the use of bituminous coal. Anthracite or coke could be employed to produce the "blue or water gas," and this non-luminous gas could be enriched by the addition of vaporized petroleum to almost any desired luminosity. The result is seen in the present status of the industry; of the 1,024 companies serving gas, 460 of the plants use the water-gas process exclusively and 170 in combination with the coal-gas process. In other words, in about 70 per cent of the gas manufactured oil enters as a most essential ingredient.

Since oil was first used by the gas manufacturers conditions of both supply and cost have materially changed. In the early days of water-gas production oil was easily procurable at a reasonable price. Naphtha, then regarded as an oil by-product, was suitable and could be bought at 1 cent a gallon. When naphtha soared in price another petroleum distillate, known as "gas oil," became available. But with the great increase in the demand for petroleum productions of all kinds gas oil, too, has risen above a refinery by-product. All efforts in the last few years to find a substitute for gas oil have brought no satisfactory practical results. On the other hand, the replacement of existing water-gas plants by plants or processes which do not utilize oil would take years to complete. And Mr. Fogg asks upon whom would rest the burden of scrapping plants representing an investment of $400,000,000 and which would require in replacement an outlay of two and one-half times as much.

The remedies which Mr. Fogg suggests are two. He would abolish the candle-power standard of determining the value of artificial gas—the use for it, he declares, does not exist now that the incandescent burner has replaced the open flame—and he would place gas for illuminating purposes upon the same basis of heating value that governs the use for cooking and all industrial operations. He would, too, adopt a sane standard of quality and bring about a downward revision of high heat values upon the ground that there appears no reason for continuing the economic waste of supplying gas of either candle-power or high calorific values when gas of lower values will satisfactorily answer every purpose and without any disadvantage to the consumer. In this way the use of petroleum in the manufacture of gas, Mr. Fogg believes, will be reduced to a minimum and a most appreciable saving will be made in the nation's oil resources.

Haverhill Gas Company Asks Rate Increase

The Haverhill Gas Light Company, Haverhill, Mass., has petitioned the Department of Public Utilities to increase the price of gas sold by the company in the city of Haverhill and the towns of Merrimac and Groveland, Mass. The present price is $1.20 per 1,000 cu. ft., in Merrimac and Groveland, and $1 in the city of Haverhill.

Oil Storage Tank Installed

A new oil storage tank having a capacity of 37,500 barrels has just been put into service by the Indian Refining Company at Lawrenceville, Ill. This work was all done by the Western Gas Construction Company of Fort Wayne, Ind., who recently furnished them with three large steel condenser pans, together with eighteen condenser towers.

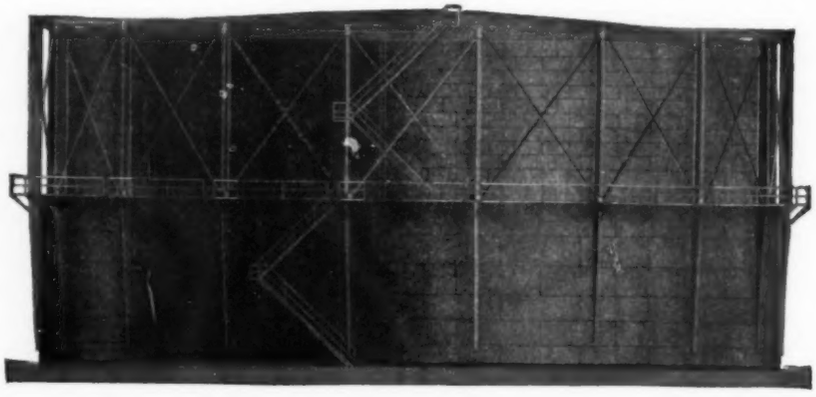
A Gas Relief Holder with Many Features

The accompanying illustration shows the relief holder now under construction for the Chicago By-Products Coke Company water gas plant. This plant when completed will have a conservative rating of 20,000,000 cu. ft. of gas per day.

The relief holder has been placed in the plant where it will receive gas from the sets as quickly as possible. There are two 42-in. inlets of this 300,000 cu. ft. holder, which will materially assist in reducing the back pressure.

The holder itself is made very broad with a view to distributing its weight over a very large area of gas and thus give the minimum pressure. At the same time this type permitted the contractors, The Western Gas Construction Company of Fort Wayne, Ind., to build the bell or gas retainer of good substantial metal, thus insuring a long life.

Another feature is the guide frame adopted for this holder, including such horizontal and diagonal bracing as to make it absolutely rigid and plumb, and incorporating an added element of strength. There is no question but that this design of the guide frame will insure that the bell or gas container will operate under all conditions of wind and weather.



GAS RELIEF HOLDER

Pacific Coast Gas Men Gather in the Southland

Second Get-Together Dinner at Los Angeles—Investigation of B.t.u. Standard Will Probably Take Two Years—Plans for Coming Convention at Portland in September

By FREDERICK S. MYRTLE

For the second time during the present season and the last before the Portland convention in September, members of the Pacific Coast Gas Association assembled at a get-together dinner to receive reports of progress from the various committees and, generally, to line up their forces for the all important annual event.

This time the dinner was held in Los Angeles, on the evening of Saturday, June 12, and the culinary resources of the City Club were taxed to provide entertainment for ninety gas men, all of whom are more or less appreciative of the good things of life. To say that the dinner was successful is to pay a now accustomed tribute to the men of the southland, who have ever arisen to the occasion when the problem before them concerned the entertainment of their friends. President A. B. Day and his associates had the affair in hand weeks before, and when they met the trains that brought in their visitors from the north they were, so to speak, armed at all points.

Reports of Various Committees

When the feasting was over President Day called for reports of committees. Secretary Bostwick read a message from Mr. John A. Britton, who, while expressing his regret at his inability to attend the gathering, wrote most encouragingly of the work already accomplished and in prospect of being accomplished by the association, notably in the investigation of B.t.u. standards which is now in process under its auspices. Other familiar faces that were missing were those of Messrs. E. C. and L. B. Jones. Secretary Bostwick, however, had a message of cheer for his audience in his announcement of the considerable additions to the membership roll from the Pacific Northwest territory.

W. M. Henderson reported for the library committee, and a report by H. M. Crawford for the piping of buildings for gas was read by the secretary. Mr. E. S. Bryant, formerly of the California State Railroad Commission, and now field engineer in the employ of the joint committee on efficiency and economy of gas, reported progress for the committee. He stated that since the last gathering in February the time had been taken up with preparations for the B.t.u. standard tests to be conducted at the agreed upon points, San Jose and Santa Barbara, but he was glad to announce that the preliminaries were now completed and that the tests would begin without delay. It is understood, however, that the investigation in progress is likely to take one to two years before a definite determination can be reached as to the best quality of gas, as measured by B.t.u. content, for manufacture and distribution to the consumer, as well as for use by the consumer. It is a matter of common knowledge that the California State Railroad Commission has, for the present, fixed the standard of gas to be manufactured and distributed to consumers at 570 B.t.u.'s, but the commission has expressed itself as being perfectly willing to be "shown" on this very important matter. The question to be decided, of course, is whether or not a lower standard makes for better all-round efficiency. The reports of tests recently made in Great Britain would seem to point to the affirmative of this much debated question.

A. H. Macbeth, president of the Southern California Gas Company, spoke upon the ever-present problem of "The Peak Load in Gas Distribution." He warned his hearers of the constantly increasing demand and of the rapidly approaching day when, unless they bend their shoulders to the wheel, the manufacturing and distributing companies would be unable to meet that demand.

Mr. F. S. Wade, of the Southern Counties Gas Company, related his experiences in a recent trip East and gave some interesting information concerning a widespread campaign of publicity undertaken in New York for the purpose of acquainting the public with the absolute necessity of gas for domestic uses.

Mr. Charles Luckenbach, of the Los Angeles Gas & Electric Corporation, entertained with a humorous anecdote.

Mr. William Baurhyte, vice-president of the last named institution and past president of the P. C. G. A., addressed his old association in happy vein.

Mr. F. S. Myrtle reported progress upon the publicity campaign to be undertaken in connection with the Portland convention and read a communication which, as he said, he "might or might not have received" from his fellow committeeman, Mr. John H. Hartog of the Rose City.

Plans for Coming Convention

Last, but by no means least, was heard Mr. W. M. Kapus, also of Portland and a director of the association, who spoke for the committee of arrangements for the coming convention. It was good to hear that some sixty members had joined up from the Northwest and that yet a greater addition to the roll might be expected between now and September. It meant the spreading out of an association whose activities hitherto have been largely confined to California. Now the cities of Portland and Spokane, aye, even Vancouver, B. C., are on the association map.

All of which goes to show that our old standby, gas, is not only still doing business, but shows every prospect of doing more business than ever.

Turlock and Modesto Gas Companies Granted Higher Rates

The Turlock Gas Company, Turlock, Cal., has been authorized by the commission to increase its charges for gas, it having been shown that recent increases in the cost of fuel oil and wages have created a financial burden that the present rates cannot support. These increases, the commission says, have added 18.2 cents per 1,000 cu. ft. to the cost of gas sold.

The new rates are fixed on a rate base of $72,921.54, the value of the plant. The new net rate for the first 500 cu. ft. per month, or less, is $1.25, as against the present charge of $1. For the next 2,500 cu. ft. the company will collect $2 per 1,000 cu.

ft., and for the next 4,000 cu. ft. $1.80 per 1,000 cu. ft. The charge for the next 8,000 cu. ft. will be $1.60 per 1,000 and for all over 15,000, $1.50.

Investigation by the commission showed that in 1919 the company's operating expenses totaled $22,660. In 1920 the cost of service will aggregate $37,410. This includes depreciation and a return of $5,830 on investment.

Rates that should be sufficient to enable the Modesto Gas Company, Modesto, Cal., to provide for the growth of its business, to continue adequate service and to raelize a just and reasonable return upon its investment were fixed by the commission following an investigation of the affairs of the company, from an operating, manufacturing and financial standpoint. The new rates are higher than the schedule now being collected. It is estimated that they will yield a return of $22,500 on a rate base of $281,958.42. In 1919 the company earned only 3.1 per cent upon its investment, a return held by the company to be too low to attract the capital necessary to enable the company to meet the demands for service created by the remarkable growth of Modesto.

Selling Balance of U. G. I. Preferred

Drexel & Co., of Philadelphia, Pa., are offering the unsold balance of a block of 7 per cent cumulative preferred stock of the United Gas Improvement Company, price par $50 and accrued dividend. The company has a total authorized capital of $15,000,000, of which $6,103,000 is outstanding. Dividends are payable quarterly and the stock is free of the Pennsylvania State tax of four mills, and the dividends are exempt from the normal Federal income tax.

The United Gas Improvement Company was organized in 1882 and operates and manages electric light and power and gas properties over a large area.

Pontiac Refuses to Increase Gas Rate

By unanimous vote the city commission of Pontiac, Mich., refused to grant an increase from $1.15 to $1.75 a 1,000 ft. for gas to the Michigan Light Company. The company maintains it cannot continue to do business at the present rate

Mayor Roper of Norfolk Addresses Annual Convention of the Southern Gas Association

Speaking to the members of the Southern Gas Association at their annual convention held at Norfolk, Va., June 22, 23, and 24, Mayor Albert A. Roper of that city stated that a public utility is entitled to a fair return on its investment over and above what it costs it to maintain its service, just as much as a man who sells potatoes is entitled to a fair return on his invested capital.

"For years it was the favorite outdoor sport among the politicians of this city to do every conceivable thing that they could to block the game of the public utilities of this city," said Mayor Roper. "It made no difference what was the virtue of the proposition which was being put forward by the public utilities. Because it was desired by the public utilities, it was wrong. You can readily understand what a short-sighted penny-wise, pound-foolish policy that was.

"In stating my views regarding the dealings of a city with its public utilities, let me say that I can see no difference between the man who sells potatoes or the man who sells lumber and the man who sells service, whether it be gas, electricity or transportation. The man who sells potatoes takes into consideration the amount of money he has invested in his establishment, the cost of producing these potatoes, his loss on the potatoes that spoil, and his overhead operating expenses, adding to that a certain amount to be agreed upon as his profit.

"I am in favor of that attitude toward the public utility which shall provide a revenue for the utility sufficient to take care of the invested capital, the depreciation, the overhead operation, and on top of that a fair return on its investment. That may be five cents per unit of travel to-day, it may be six cents to-morrow, it may be ten cents six months from now, and a year from now it may be four and a quarter cents.

"But whatever it is, the man who invests his money in service and in transportation, and in gas, whatever the service may be, is entitled to a fair return upon his investment over and above what it costs him to produce that service, just as truly as a man who buys trees and cuts them up and makes them into tongued and grooved lumber and sells them, is entitled to a fair return on his invested capital. That is all there is to it."

Washington Company Raises Price of Gas

Under an order of the Public Utilities Commission of the District of Columbia, the price of gas in Washington will be increased from 95 cents to $1.25 per 1,000 cu. ft. In March, 1919, the commission granted the Washington Gas Light Company an increase in rates of from 90 cents to 95 cents per 1,000 cu. ft. to domestic consumers. This increase, which was to continue until the spring of 1920, was based on the increase in the cost of manufacturing and distributing gas during the war. Like all other gas companies, the Washington company has in recent months encountered many difficulties in meeting its requirements for oil, and when the 95 cent rate expired by limitation of the order, the company petitioned the Utilities Commission to fix a base rate of $1.08 per 1,000 cu. ft. with an oil adjustment clause. This clause was to assume that the company could buy oil at 7½ cents per gallon and the selling price of gas was to fluctuate each month as the cost of oil increased or decreased from 7½ cents. The company stated that the price paid for oil for its requirements for the month of June was 12½ cents per gallon, which would have made the rate $1.30 per 1,000 cu. ft. had the commission adopted the suggestion of an automatic adjustment of rate based on the fluctuations in the price of oil. The commission's decision established a fixed price for gas for three months of $1.25 per 1,000 cu. ft.

Gas Plant Sold at Auction

The gas plant at Grand Ledge, Mich., has been sold at auction. Attorney R. A. Latting, being the highest bidder, was awarded the property. There was only one other bidder, although the competition was keen at Grand Ledge between the opponents and friends of the company which went into bankruptcy some time ago. The plant is still supplying gas, but its future is as yet undetermined. Grand Ledge is said to be the smallest city in the State having a gas plant.